

## SUSTAINABLE HALAL FOOD PRODUCTION - LOCUSTA MIGRATORIA AS UNUSED POTENTIAL

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### **Abstract**

Growing world population, limited agricultural resources for food production and global pollution represent an imperative to find an alternative to conventional food production (primarily meat). In order to achieve this goal, it is necessary to establish a sustainable diet with a reduction in meat consumption and / or the use of alternative sources of protein. *Locusta migratoria* (locusts) are a species believed to be one of the oldest living things in the world. In some Islamic countries, they are used as food (e.g. Indonesia and Malaysia) and have untapped potential in Western countries. Grasshoppers represent a long-term sustainable solution due to significantly lower prices of cultivation and production, but also a much smaller impact on the environment (primarily greenhouse gas emissions and waste generation - zero waste). In addition to the positive impact on the environment, their nutritional values make them an attractive alternative (high content of protein, unsaturated fatty acids and minerals).

The EU has recognized the potential for commercialization of alternative protein sources by approving *Locusta migratoria* as a novel food, safe for human consumption. Given the skepticism of Western consumers, the approval by European Member States is a turning point as it guarantees that locusts are a safe source of food for humans and that all legal provisions are in place to ensure quality and safety.

**Keywords:** *Locusta migratoria*, sustainable production, new food, halal, food safety

**JEL codes:** L66

## INTRODUCTION

Social and demographic changes brought by technological progress and the progress of civilization, as well as the significant decrease in the availability of arable land with the simultaneous growth of demand from consumers, represent a challenge for today's industry and food production, giving an imperative to further progress and development of food production, finding alternative and sustainable ways of production [1]. Also, the COVID-19 pandemic and the currently unstable geopolitical and energy situation have a significant impact on social and economic development and ensuring the stability of food production and distribution [2]. Great challenges are also represented by the predicted increase in the total human population - up to 9.7 billion in 2050 while at the same time the demand for food is expected to grow by 70%, especially in terms of meat and products of animal origin [3].

Study of Žuk - Gołaszewska et. al. state: "Numerous studies have identified significant threats to the stability of the global food chain, including the reduction of food protein production and climate change as early as 1975, Meyer-Rochow proposed that insect farming could offer an alternative solution to the global protein deficit" [2].

The presentation of insects in the modern human diet as a potent source of nutrients could have a positive impact on reducing the protein gap. According to Žuk - Gołaszewska et al. "Entomophagy is a new component of the food production system in the European Union. Edible insects are recently classified as farm animals (livestock). Previously, bees were the only insects classified as livestock. Edible insects are considered a new food, and their nutritional potential could be used in the production of food for livestock and domestic animals and in human nutrition" [2].

*L. Migratoria* represent an available and interesting potential due to its high nutritional value, more environmentally friendly production process and production costs that are lower compared to conventional production [2].

In addition to current risks that require changes in the way food is produced, market needs and business opportunities should also be taken into account. Islam has become the fastest growing religion in the world and the halal food market is one of the largest consumer markets in the world as reported by the Stated of The Global Islamic Economy Report in Thomson Reuters (2014). All Muslims want to ensure that their food is halal. According to Islamic literature, the Prophet ate locusts. Also, consumers are generally interested in consuming low-calorie and healthy food [3].

The aim of this paper is to provide an overview of recent scientific literature and legislation for assessing the potential of sustainable grasshopper production.

## NUTRITIONAL AND ENVIRONMENTAL ASPECTS OF GRASSHOPPER BREEDING

To increase livestock production, additional arable land must be provided for cultivation, which can lead to deforestation and the long-term sustainability of such a method of food production is questionable. Therefore, the possibilities of bridging

current and future food production and consumption represent the exploitation of new, unconventional sources of food. According to the research of Shrivastava et al. “The cultivation of grasshoppers and other edible insects requires significantly less food, land and water compared to livestock production, which is known to have a significant impact on the environment. In contrast, greenhouse gas emissions are minimal from grasshopper production. In general, edible insects represent a significant biological resource rich in proteins, amino acids, fats, carbohydrates, various vitamins and trace elements” [3].

Recently, the interest in entomophagy has increased and some food companies are getting creative with insect-based food production. Although grasshoppers are consumed in Arabia and Africa, less known is that they are actually widespread around the world (4). Popular grasshopper foods include fried, baked, or boiled meals. Lately, grasshoppers are in focus because they have interesting organoleptic properties, they are rich in nutritional properties and their production shows promising results [4, 5].

According to Clarkson: ”The content of locusts is comparable to traditional meat sources, indicating potential as a meat or protein alternative for a growing population. There are currently only a few commercial insect-based products sold on the Western market, and they include ground insect flour, which is sold on its own or as an ingredient in various bars, chips, cookies or pasta” [6].

Clarkson also states that: “Locusts are less popular and so far very few products use extracted insect protein as a feed or feed ingredient. Even with the promising potential of grasshoppers as an alternative food source, consumers in Western countries must first accept the idea of consuming insects. The enculturation of viewing animal products as a source of protein and fat and viewing insects as pests that people try to avoid, has caused the avoidance of new insect products, also known as neophobia (fear of new foods). In order to successfully present locust products, it is necessary to work on a better understanding and research of the properties of locust proteins and the development of products based on them” [6].

Positive aspects of grasshopper breeding also refer to the fact that grasshoppers have a short life cycle in which, depending on the breeding, maturity can be reached in a maximum of eight weeks. Study of Mariod et al. shows that “they can also increase their numbers 10 to 16 times between each generation, illustrating the prospects for rapid and efficient domestic breeding” [4]. Required land for cultivation is minimal because they can be grown vertically. According to Van Huis et al.: “They show high feed conversion efficiency and resource requirements for insect farming are lower compared to other traditional livestock farming such as beef” [5].

## **TECHNOLOGICAL ASPECTS AND REQUIREMENTS FOR FOOD QUALITY AND SAFETY**

Since the use of wild locusts as a food source is forbidden in western countries, large-scale mass production (farming) of edible insects is considered a viable solution. According to Henchion et al. ”Cultivated insects need to meet food safety requirements, which presents significant technological, social and economic

challenges. This new protein source requires the development of new solutions regarding the optimization of production costs, food safety and consumer acceptance”[1]. Gołaszewska et al. state: “The production of edible insects is also limited by legal regulations and social factors. Knowledge of edible insect production technologies is scarce, and producers have limited experience in the distribution and sale of edible insects in Europe” [2].

Locusts represent an optimal type of insect for food production, the cultivation of which does not require highly sophisticated equipment. They feed on a wide range of materials, show resistance to changes in breeding microclimate and great possibilities for use as food and feed. The very fact that they are very available throughout the year, that cultivation is relatively simple and that the possibilities of processing grasshoppers into different forms of food are great can represent decisive parameters for choosing insect breeding [1].

In the EU, there are a number of regulations that regulate the production of food of animal origin, animal feed and animal by-products. Among the most important are Commission Regulation (EC) no. 1069/2009, (EC) no. 767/2009, (EC) no. 999/2001, (EC) no. 853/2004 and (EC) no. 1137/2014.

According to the research of Gołaszewska et al.: “These legal acts represent the basic principles of safety in the production of animal based food and feed and standards in the production of edible insects for human and animal consumption. Also, legal regulation is a key prerequisite for the development of insect farming and effective marketing of insect-based food. Sustainable insect farming requires dedicated infrastructure and resources, including buildings, equipment and personnel. Insect production should be effectively managed to maximize yields and profits to obtain products that meet food safety requirements. Safe production of locust-based food requires the implementation of dedicated management systems, including good husbandry practices, good hygiene practices and HACCP” [2].

On the basis of EFSA opinion of October 8, 2015 (17), which concluded that if insects are fed with substrate that does not originate from ruminants or humans, and the risk itself is equal or lower than the risk of currently approved animal protein sources, amendment of Commission Regulation (EU) no. 2017/893 was adopted, which recognized insects as novel food (18). Products classified as new food are easier to register and it is additionally possible to put parts of locusts and products based on locusts (e.g. flour) on the market in addition to whole locusts. The regulatory framework covers the entire production chain since, as with conventional production, locust farming needs to be monitored to ensure the safety and quality of the finished product. The cultivation itself is under the supervision of competent authorities in order to ensure a safe product for consumers [2].

It is very hard to exactly determine the global consumption of [11]. Currently, more than 2000 species of insects are consumed in more than 80 countries with grasshoppers accounting for 13% of global consumption [2]. In 2019, 500 tons of insect food were produced in the EU. Research of Gołaszewska et al. shows that “According to some estimates, around 1 million tons of edible insects will be produced by 2030 and processed into 260,000 tons of insect-based food. These products will reach 390 million consumers. The market value of edible insects is expected to reach around 2 billion euros by 2030” [2]. The leading country in the cultivation of

grasshoppers in the EU is the Netherlands, where the average selling price of 35 g of grasshoppers is 9.99 euros [2].

## **SUSTAINABLE PRODUCTION AND ENVIRONMENTAL ASPECTS**

Greenhouse gas emissions represent a major global problem. Global warming comes from industrialization, agriculture, and similar activities such as crop fertilizer production, farm energy costs, feed transportation, animal waste processing, ruminant intestinal fermentation, and domestic animal waste. On the other hand, the cultivation of Locusts offers great potential for environmental protection due to the high conversion of food, the possibility of cultivation on waste products, the use of less water during the cultivation cycle and the like [3].

Also, since grasshoppers are cold-blooded animals, they need minimal amounts of food to produce energy and heat. Studies have shown that the production of 1 kg of poultry meat requires at least 2.5 kg of feed, the production of 1 kg of pork requires 5 kg of feed, and the production of 1 kg of beef requires 10 kg of feed. On the other hand, grasshoppers need only 1.7 kg of food to produce 1 kg. In addition, utilization of protein and other nutrients in chicken is 55%, and in beef 40%, while grasshoppers have utilization of 80% [3].

The continued depletion of natural resources leads to further adverse effects on the environment. In this context, insect breeding stands out as an ecologically acceptable alternative. Low demand on agricultural land compared to conventional livestock production and high utilization rate of waste products are additional reasons why locust farming has such great potential for sustainability [12, 13].

As with conventional animal cultivation, by-products are created in the production of insects. In addition to mortality, grasshopper excrement is produced, which has great potential as a fertilizer (e.g. organic fertilizer, compost material or soil improver). The NPK profile of excrement shows that it contains certain beneficial bacteria that promote plant growth, thereby improving plant health and facilitating nutrient absorption. Locust excrement is used as fertilizer in nurseries and viticulture and represents a valuable alternative to today's conventional fertilizing products, which has an additional positive effect on the use of mineral fertilizers.

Also, the use of the by-products of locust farming is in line with the principles of the circular economy since the reintroduction of valuable substances into the production chain is an alternative to linear models where waste is in most cases disposed of by burning or dumping in landfills [14].

## **WESTERN MARKET**

European consumers have rather reserved attitudes towards entomophagy. A number of factors have an impact on the acceptance of insect-based products, from availability, added value of perceived benefits and risks of consumption, availability of information about the production itself and the quality of product. Consumers more easily accept new products if there is trust in the claims of institutions, manufacturers,

researchers and users of the product in order to overcome previous attitudes and opinions regarding insects (i.e. unsanitary), social influence and feelings of fear, revulsion and indifference [2].

Current market challenges are increasing consumer awareness about the safety of grasshoppers as food, increased diversity of insect food, favorable prices of finished products, effective management of food waste and introducing legislation that facilitates international trade in edible insects [15]. According to Payne, C et al.: “Promotion, especially towards young consumers, appears to be key determinants of building wider social acceptance of entomophagy and facilitating the adoption of a locust-based diet. In the commercial sector, insect farms and insect products are financially viable, and investor capital has made it possible to emerge many new insect food companies” [16]. Consequently, Gołaszewska et. al. state: “These observations indicate that social awareness of entomophagy needs to be improved to encourage consumers to try insect-based products and the introduction of insects into the food industry” [2].

Consumer awareness of insect food is mainly determined by availability, food knowledge, food taboos, experience and ideology. It is necessary to invest efforts in consumer education, primarily in informing consumers that grasshoppers are safe for human consumption and that they represent an alternative source of safe food with a positive impact on the environment [2].

## **FUTURE**

Since insect-based nutrition is still taboo in Western countries and insects are not yet accepted as food, it is necessary to address consumer education to ensure the acceptance of grasshoppers as a source of new food and encourage the development of this food industry [2].

In the locust-based food industry, it is necessary to ensure that the final product is attractive in terms of texture, smell and taste. In order to successfully present locust products, it is necessary to work on a better understanding and research of the properties of locust proteins and the development of products based on them, along with constant consumer education.

Although awareness of entomophagy in Western countries is still low, growing grasshoppers as a sustainable source of food represents great potential, but more efforts are needed to raise the level of awareness and accept the consumption of grasshopper products among consumers [2].

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